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Title:
IMPROVED DETECTOR

Abstract:

A detector 1 having a sensor 15, an aspiration system 10, and a power source, whereby the aspiration system 10 includes two or more aspirators 16a, 16b. A method of operating the detector 1 is also disclosed, as is a trap 70 for absorbing output from a laser 66 used to detect particulate matter passing through the detector 1, wherein the trap 70 includes an absorption plate orientated substantially at a Brewster angle to the light 72 from the laser 66.

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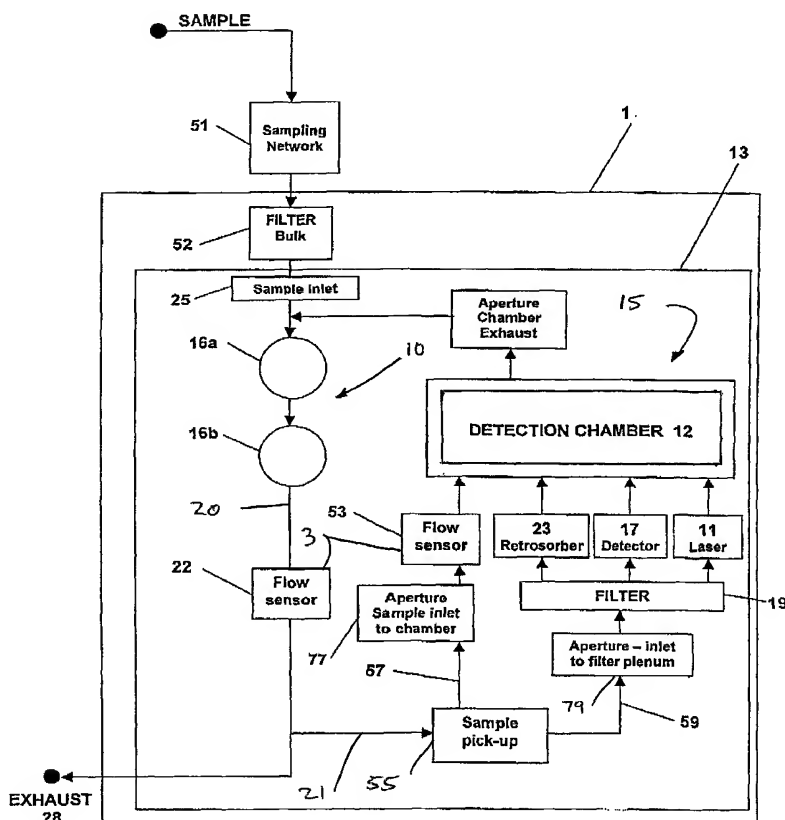
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(54) Title: IMPROVED DETECTOR



(57) Abstract: A detector (1) having a sensor (15), an aspiration system (10), and a power source, whereby the aspiration system (10) includes two or more aspirators (16a, 16b). A method of operating the detector (1) is also disclosed, as is a trap (70) for absorbing output from a laser (66) used to detect particulate matter passing through the detector (1), wherein the trap (70) includes an absorption plate orientated substantially at a Brewster angle to the light (72) from the laser (66).



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Improved Detector

Field of the Invention

The present invention relates to a detector particularly, but not exclusively, an aspirated smoke detector.

5 Background

The detection of small particles in aspirated air (inferred as smoke) is commonly used as a method of detecting overheated components or a fire. The more sensitive a smoke detector is, the earlier it is able to detect smoke. Early detection of smoke provides more time for action to be taken once smoke has been detected. In this
10 regard, laser based aspirated smoke detectors have become commercially successful as early warning detectors of smoke.

A typical aspirated smoke detector will have a detection chamber including a light emitter and light detector(s), an aspirator for moving sample through the detector chamber, and be connected to ducts to bring the sample from a monitored area. The
15 ducts typically form a network to enable sample to be monitored from more than one zone or area. Each zone may have a different ambient pressure depending on such factors as ventilation, door location etc. The flow rate along the duct must enable smoke to be detected within a pre-determined time frame, for example, 1 minute from entry into a duct of the smoke detection system. For this reason, forced aspiration of
20 the smoke detector is very important. In order to overcome problems in pumping the sample through a number of pipes where there may be differing pressure gradients larger more powerful aspirators have been used.

Other constraints are typically placed on smoke detection systems, such as being able to operate in the event of a power failure. Typically, a smoke detection system must
25 continue detection in the event of a primary power failure for a period of 24 hours. Additionally, after 24 hours with no primary power, the detector must also be able to sound an alarm for a further period of 30 minutes. The smoke detection system therefore requires sufficient power from a backup system. Problems with known

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detectors include their power requirements, including the back-up power requirements for the detector to operate in a no power situation.

Further constraints on a smoke detector system are imposed on its size in some applications. One application where smoke detectors are increasingly being used is in or around cabinets containing electronic equipment, such as computers. The computers may be servers holding important or valuable information. It is therefore very important to be able to provide early detection of smoke in the cabinet so that the server may be shut down in an orderly fashion, to ensure data is not lost and the functions of the server may be transferred to an alternative machine. In-cabinet detectors are therefore an important market segment. As cabinets are limited in size, the smoke detectors must also be limited in size. It should be noted that size is important in a number of applications, for example, it may be desirable to place aspirated smoke detectors in vehicles that have limited amounts of room, such as aircraft. Further, reducing the size of the detector and associated apparatus generally reduces power consumption, reduces material cost, and allows the detector to be used in a wider variety of applications. Aspirated smoke detectors are generally more complicated, larger and expensive than traditional point detectors, and reducing cost and size would allow an aspirated smoke detector to be used in a wider range of applications, such as single or adjoining rooms.

An additional constraint placed on in-cabinet detectors is that the detector should not require any maintenance for an extended period, for example, 10 years. Components in the smoke detector wear and fail, and premature failure of known smoke detectors is a problem.

One component of a smoke detector that is critical to the detection of particles, and therefore smoke, is the detection chamber. A laser emits a beam of light and smoke particles scatter some of the light onto a detector. An increase in the amount of scattered light indicates an increase in the amount of particles (eg smoke) passing through the detection chamber. Detectors commonly include or are associated with a light trap, where the light that has passed through the detection chamber is received. Known light traps use a material which absorbs some of the light and reflects the

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remainder into the body of the light trap. The light usually undergoes a number of reflections before the remaining light travels back into the chamber, where it may interfere with the scattered light. Given the extreme sensitivity of the detector, even small amounts of light returning from the light trap will impair the function of the smoke detector.

The amount of light returning to the detection chamber can be reduced by increasing the number of reflections of the light. However, in known light traps for smoke detectors, this has resulted in an increase in the size of the light trap. This is undesirable in a small detector. A problem exists in providing a better light trap that is of reduced size compared to existing traps, while maintaining an efficient collection of unwanted light.

Object

The present invention seeks to address at least one of the problems associated with known detectors.

Summary of the Invention

In accordance with one aspect of the present invention there is provided a detector having a sensor, a controller, an aspiration system, and a power source, whereby the aspiration system includes two or more aspirators.

The provision of multiple aspirators allows the detector to operate over a greater flow rate range and may also extend the service life of the detector as, in general, only one aspirator is in use at any one time. This also provides the advantage that if one aspirator fails the second aspirator may still operate, extending the overall life of the detector. This is based on the surprising discovery that a common failure mode of aspirated detectors is failure of the aspirator itself due to failure of a bearing.

The aspirators may be operated cyclically during normal operation, such that only one aspirator is operated at a time. One advantage of this arrangement is the life of the detector will be extended considerably compared to a detector having a single aspirator.

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The detector may include a detection mechanism for determining whether either aspirator is operational. One advantage of this embodiment is, if one aspirator fails another may be operated to ensure the detector operates within specification.

5 The detection mechanism may include a flow meter for estimating the flow rate through a detection chamber of the sensor. In this way the detector can be operated within specification in relation to the detection of smoke.

The detection mechanism may also include a flow meter for estimating the flow rate through the detector as a whole. This provides another check on aspirator performance and consequently ensures that the detector unit operates within
10 specification.

The controller may be adapted to operate more than one aspirator at a time. One advantage of this embodiment is that the flow rate through the detector unit can be increased if required, for example in a test.

15 The sensor, aspiration system and controller may be mounted on a printed circuit board.

In accordance with another aspect of the present invention there is provided a method for operating a detector having a sensor, at least two aspirators, and a controller for the aspirators, including the steps of:

- (a) operating a first aspirator for a predetermined period;
- 20 (b) turning off the first aspirator after the end of the predetermined period;
- (c) turning on another aspirator for a second predetermined period to continue airflow to the smoke sensor.

such that only a single aspirator is operated for the majority of the predetermined period and airflow through the sensor is maintained above a minimum predetermined
25 flow rate.

In another aspect, the present invention provides a detector having a housing and a trap for absorbing output from a laser used to detect particulate matter passing through the detector. The trap includes an absorption plate orientated substantially at a Brewster angle to the laser light.

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In an embodiment, the absorption plate is constructed from the same material as the housing.

In an embodiment, a polarisation plane of laser light incident on the plate is so orientated that the plate absorbs the majority of the incident light. In this way,
5 virtually all light will be absorbed at the plate, and negligible quantities of light will be reflected for subsequent escape back into a detection chamber of the detector. This arrangement reduces the size of the trap while retaining the performance of a larger device.

In one embodiment, the detector is a smoke detector.

10 **Brief Description of the Drawings**

The present invention will now be described, by way of non-limiting example only, with reference to the following drawings, in which:

Figure 1 shows a schematic block diagram of an aspirated smoke detector of the present invention;

15 Figure 2 shows a schematic representation of a first embodiment of the aspirated smoke detector of figure 1 situated in a three bay cabinet;

Figure 3 shows a schematic representation of a second embodiment of the aspirated smoke detector of figure 1 situated in a three bay cabinet;

20 Figures 4a and 4b show schematic representations of the aspirated smoke detectors of figure 1 located adjacent to rooms;

Figure 5 shows a representation of a light trap in accordance with another form of the present invention.

Detailed Description

A schematic view of a smoke detector 1 is shown in Figure 1 as including an
25 aspiration system 10 and a smoke sensor 15, mounted on a printed circuit board (PCB) 13. The aspiration system 10 has two aspirators 16a, 16b that serve to draw air through the detector 1, from inlet port 25, that may be integrally formed in the PCB 13, to an exhaust 28. Air is also caused to pass through an aperture 55, for introduction to a detection chamber 12 of the smoke sensor 15. Flow sensors 22, 53

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and control circuitry (not shown) are also mounted to the PCB 13, with additional components required for the operation of the detector 1, as will be described below. The flow sensors 22, 53 are preferably in the form of flow meters. A variety of flow meters are able to be used in the present invention, including a resistive temperature device such as a thermistor.

The flow sensors 22, 53 together form a detection mechanism 3 for estimating flow rate either individually or collectively through the detector 1, as a whole, or the sensor 15 above.

First aspirator 16a and second aspirator 16b each have respective housings (not shown). In the present embodiment, the PCB 13 is itself also mounted in a housing (not shown). A bulk filter 52, which filters all the air entering the housing, may also be located within the housing, or in a sample pipe coupled thereto.

In operation, an air sample enters the detector 1 through a sampling network 51, which includes, for example, ducts 24 shown in Figure 3. The sample passes through inlet port 25 then through aspirator 16a and 16b. Most of the sample is immediately exhausted from the detector 1 through exhaust 28. The remainder of the sample that is not exhausted, passes through a sample pick up point in the form of the aperture 55, which may also be integrally formed in the PCB 13. From the aperture 55, the sample is diverted into two streams, being the sample stream 57 and ventilation stream 59.

The ventilation stream 59 passes through aperture 79, also formed in the PCB 13, and then passes through filter 19 where further particles are removed, to become "clean" air. The clean air flows in to detection chamber 12 where it is used to keep sensitive parts of the detector free from deposited particles. Particles from the sample air are known to interfere with certain workings of the detector.

The clean air is separated into three flows where it is directed through apertures (not shown) in the PCB 13 to the region of a light detector 17, a retrosorber 23 and a laser light generator 11, which are all housed in detection chamber 12. It has been found that a flow of clean air can be used to protect the light detector 17, retrosorber 23 and

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laser light generator 11 by keeping the respective surfaces clean and functioning optimally.

The sample air that does not pass through the clean air filter passes through an aperture 77 in the PCB 13, past a second flow sensor 53 into detection chamber 12 through inlet 61 (as shown in figure 5). The sample air passes through a detection volume 60 where some of the entrained particles scatter light onto a detector 17 mounted to the PCB 13. The sample then exits the detection chamber 12 through exhaust 62. Exhaust 62 passes the sampled air back into the air flow that passes through the aspirators 16a, 16b.

As only a small portion of the total sample air enters the aperture 55 to be diverted to the detection chamber 12, very little sample air is recirculated for a second or further circuit through the detection chamber 12. Control systems may be calibrated to compensate for the small amount of recirculated air when warning of excess particle detection possibly indicating smoke.

In the above-described detector, there is a main sample path 20 and a sample loop 21. The main sample path 20 includes the sample entering the detector 1 from the sampling network 51, being filtered, passing through the aspirators 16a and 16b, and exhausting the system through exhaust 28. The sample loop 21 passes through the detection chamber 12, and includes taking a sub-sample of the main sample from downstream of the aspirators 16a, 16b, and passing that sub-sample through the sensor 15, where it is exhausted into the main sample path 20 upstream of the aspirators 16a, 16b. This system has many advantages, including the advantage that the pressure gradient across the detection chamber 12 is increased by placing the sub-sample pick up point or aperture 55 at a location having high pressure, and exhausting the sample to a low pressure area (before the aspirators 16a, 16b). This is important as the sample loop 21, including the detection chamber 12, typically has a high resistance to flow.

An advantage of the present embodiment is that the first flow sensor 22 in the main sample path 20 detects the speed of the sample flowing through the detector 1, whereas the second flow sensor 53 in the sample loop 21, detects the speed of the

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sample flowing through the sensor 15. The use of two sensors 22, 53 provides a better resolution of the flow of sample air into the detector, whereas the second flow sensor 53 provides information regarding the amount of flow actually reaching the detection chamber 12.

5 As shown in the cross sectional drawing of the detection chamber 12 in figure 5, the detection chamber 12 includes a laser light generator 11 formed of a laser 66, lens 68 and filters 70 arranged to produce a light beam 72. The light beam 72 passes through the detection volume 60, and into retrosorber 23. Some of the light beam 72 is scattered by particles in the air flowing through the detection volume 60. Some of the
10 scattered light is detected by the detector 17 in a known manner, and this information is relayed to an known alarm system that typically has preset thresholds for particle detection. As in present alarm systems, if the level of particles detected per unit of air exceeds the preset limits, an alarm may sound.

The vast majority of the light reaches the retrosorber 23, which is in the form of a
15 light trap 70 for absorbing output from the laser 66, where it must be prevented from re-entering the detection volume 60. The trap 70 includes a plate 71 with an initial impinging surface 74, and a further reflection surface 76. The material of the initial impinging surface 74 is chosen such that, at a predetermined (Brewster) angle for that material or substantially thereat, a higher proportion of the light is absorbed than at
20 other angles. This greatly increases the amount of light being absorbed by the impinging surface 74. Preferably, the light is substantially polarised and oriented in a predetermined plane, as this increases the absorption of the light at the Brewster angle. Similarly, the light is preferably substantially monochromatic, as the Brewster angle is dependent on the frequency of the light. It has been discovered that a laser
25 diode produces a suitable monochromatic light source that is sufficiently polarised. However, other substantially monochromatic or polarised light sources are suitable. In another form, the light source may be a broad-spectrum unpolarised light source, wherein appropriate filters are placed in the detection chamber 12 to produce a substantially monochromatic polarised light beam.

The initial impinging surface 74 is ideally substantially planar. In the present embodiment, the reflection surface 76 is approximately parallel to the impinging surface 74.

5 The arrangement of the retrosorber 23, or light trap 70, results in the light impinging on the initial impinging surface 74, then the reflection surface 76. The light reflecting from surface 74 is polarised, but in a plane whereby the advantage of the Brewster angle is not achieved. However, it has been discovered that sufficient absorption takes place after the first reflection such that orientation of the second surface to the Brewster angle for the reflected light is not required. For this reason, impinging
10 surface 74 and the reflection surface 76 may be parallel, which has significant advantages in reduction of the size of the trap 70 and in manufacturing cost. In order for the light to exit the retrosorber 23 as shown in Figure 5, the light must reflect at least 6 times, resulting in a significant reduction in the light re-entering the detection chamber, while reducing the size of the trap compared to known traps.

15 The reflection surfaces 74 and 76 may be constructed from a polymer material having high light absorbency at the Brewster angle and orientated at the correct plane relative to the incident light's plane of polarisation. In the present embodiment the material used in the surfaces 74 and 76 is the same as the material used for the detection chamber 12, as this provides the advantage that the detection chamber 12 can be
20 moulded from a die in one piece. The use of a common material reduces the number of parts required, as well as material and manufacturing costs, while retaining an effective light trap 70. If increased performance is required, the surfaces 74 and 76 may be coated or have specially prepared panels attached.

Various applications of the detector will now be described in more detail with
25 reference to Figures 2 to 4.

As shown in the embodiment in Figure 2, ducts 24 carry air from a monitored zone, such as the interior zone 26 of cabinet 110, to the smoke detector 1, where it is exhausted from outlet 28.

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During operation, a minimum flow rate is required to ensure that any smoke in the sample is detected within a predetermined elapsed time of it entering the duct network. The network may be quite large when used to protect rooms, for example covering 150m² of floor space. Determination of flow rate is also required to

5 ascertain the concentration of particles in the sample air. In normal operation of the present embodiment, a single aspirator 16a or 16b is sufficient to draw air through the duct and detector chamber 12 and out exhaust 28. The controller (not shown but part of the circuits on the PCB 13) determines which aspirator 16a or 16b is operating, and cycles between the aspirators to provide equal operational time per aspirator. For

10 example, the controller may run each aspirator for a period of 4 hours per cycle, alternating between the two aspirators such that each aspirator receives equal time in operation. If one aspirator fails, the controller may indicate a fault and transfer power to the other aspirator continuously to ensure that the detector system continues

operating within the set parameters. The cycling process may be time based to ensure

15 that the aspirators are operational for approximately the same number of hours. Alternatively the cycling process may be revolution based, as the aspirators may not run at full speed at all times and the controller ideally has sensors to detect motor speed.

The controller is able to determine the sample flow rate required by receiving data

20 from the flow meters. Therefore an aspirator may be run for a particular number of revolutions before the power is cycled to another aspirator.

When cycling the power to the aspirators, it may be desirable to run both aspirators simultaneously to ensure that the sample flow rate is not reduced while one of the aspirators reaches operational speed.

25 Due to the compact size of the smoke detection system, and as the system may be housed within a cabinet, performing maintenance on the system is difficult and not cost effective. Further, the cost of shutting down a server to service a detector may be prohibitive. Therefore, lifetimes of 10 years or more are desirable for these products.

In another embodiment, shown in Figure 3, the ducts 24 for the detector 1 are situated

30 at the exhaust of a number of fans 112 of cabinet 110. The exhaust fans 112 in the

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cabinet are used to provide airflow through the cabinet to keep the electronic components enclosed therein, within an operating temperature range. It is quite common for computer cabinets to be ventilated with fans 112 as significant heat may be generated by the electronic components contained therein. The outlet 28 is situated
5 such that there is a pressure gradient between the inlet and the outlet to promote flow through the detector system 10. This may allow the aspirator to operate at a lower speed.

Periodically during the life of the detector system, it is desirable if not necessary, to test the operation of the smoke detector, and in particular, whether the ducts 24 and/or
10 inlet 25 have become blocked. Blockages have been known to occur, especially in situation where there is a high level of ambient dust and airborne material. When testing flow rate, both aspirators 16a, 16b may be engaged to increase the flow rate to ascertain whether the maximum flow rate reflects the expected value (determined by previous testing or known estimates for a particular unit and configuration.)

15 It is also possible that more than one aspirator can be run at once in adverse conditions, for example when running a single aspirator does not produce sufficient flow for detection or when air flow times exceed specification.

When situated in or adjacent to a room, as shown in Figures 4a and 4b, the detector 1 can be used to detect levels of smoke or other pollutants such as particles suspended
20 in the air. In the arrangement shown in Figure 4a, a network of ducts 300 may be used to sample air from one or more rooms 301. Alternatively, as shown in Figure 4b, the detector 1 may be used to sample air from an air conditioning duct 305 or other air transfer mechanism for a room 303, which would reduce the requirement for extra ducting.

25 Ducting may also be removed from the detector 1, as compared to a conventional smoke detector, since a number of the detector components are mounted to the PCB, on opposite sides thereof, and all interconnecting apertures can be formed directly in the PCB. Thus, many of the conduits are merely apertures in the PCB. This reduces size as well as construction costs by reducing the number of parts. There is also no
30 wiring loom on the PCB, as all elements are mounted to the PCB. The reduction in

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size of the smoke detector 1 is a particular benefit of having the components mounted to both sides of the PCB 13, as well as having apertures in the board to facilitate air movement. This, in conjunction with the use of small and efficient light traps, can reduce the overall size of the apparatus.

- 5 Overall, including the abovementioned features can reduce the size of the housing of the detector 1 significantly, as well as decreasing power consumption and material costs. In the present specification, the term “clean” air refers to air that has been filtered to remove particles that may settle on sensitive parts of the detector. Sample
- 10 air may contain particles that are associated with smoke or other particles to be measured, and therefore excess filtering of sample air may reduce the sensitivity of the detector. The clean air provides a barrier to protect the sensitive parts of the detector to prevent particles settling on the surface of the parts, which assists in maintaining the sensitivity and calibration of the detector over an extended period of time.
- 15 Further, throughout the specification, reference has been made to detection of smoke, however, it should be appreciated the invention may have application to detection of any other type of particulate matter or impurities flowing through the detector.

The Claims:

1. A detector having a sensor, a controller, an aspiration system, and a power source, whereby the aspiration system includes two or more aspirators.
2. A detector as claimed in claim 1, wherein the aspirated detector includes a
5 detection mechanism for determining whether either aspirator is operational.
3. A detector as claimed in claim 2, wherein the detection mechanism includes a flow meter for estimating the flow rate through a detection chamber of the sensor.
4. A detector as claimed in claim 2, wherein the detector includes a flow meter
10 for estimating the flow rate through the detector as a whole.
5. A detector as claimed in claim 1, wherein the controller is adapted to operate more than one aspirator at a time.
6. A detector as claimed in any one of claims 1 to 5, wherein the sensor, aspiration system and controller are mounted on a printed circuit board.
- 15 7. A method for operating a detector unit having a sensor, at least two aspirators, and a controller for the aspirators, including the steps of:
 - (a) operating a first aspirator for a predetermined period;
 - (b) turning off the first aspirator after the end of the predetermined period;
 - (c) turning on another aspirator for a second predetermined period to
20 continue airflow to the smoke sensor,such that only a single aspirator is operated for the majority of the predetermined period and airflow through the sensor is maintained above a minimum predetermined flow rate.
8. A trap for absorbing output from a laser used to detect particulate matter
25 passing through a detection chamber, wherein the trap includes an absorption plate orientated substantially at a Brewster angle to the laser light.

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9. A trap as claimed in claim 8, arranged whereby a polarisation plane of laser light incident on the plate is so orientated that the plate absorbs the majority of the incident light.
10. A trap as claimed in claim 8, wherein the absorption plate is constructed of the
5 same material as the trap.
11. A trap as claimed in claim 8, wherein the trap is formed integrally with a housing for the detection chamber.

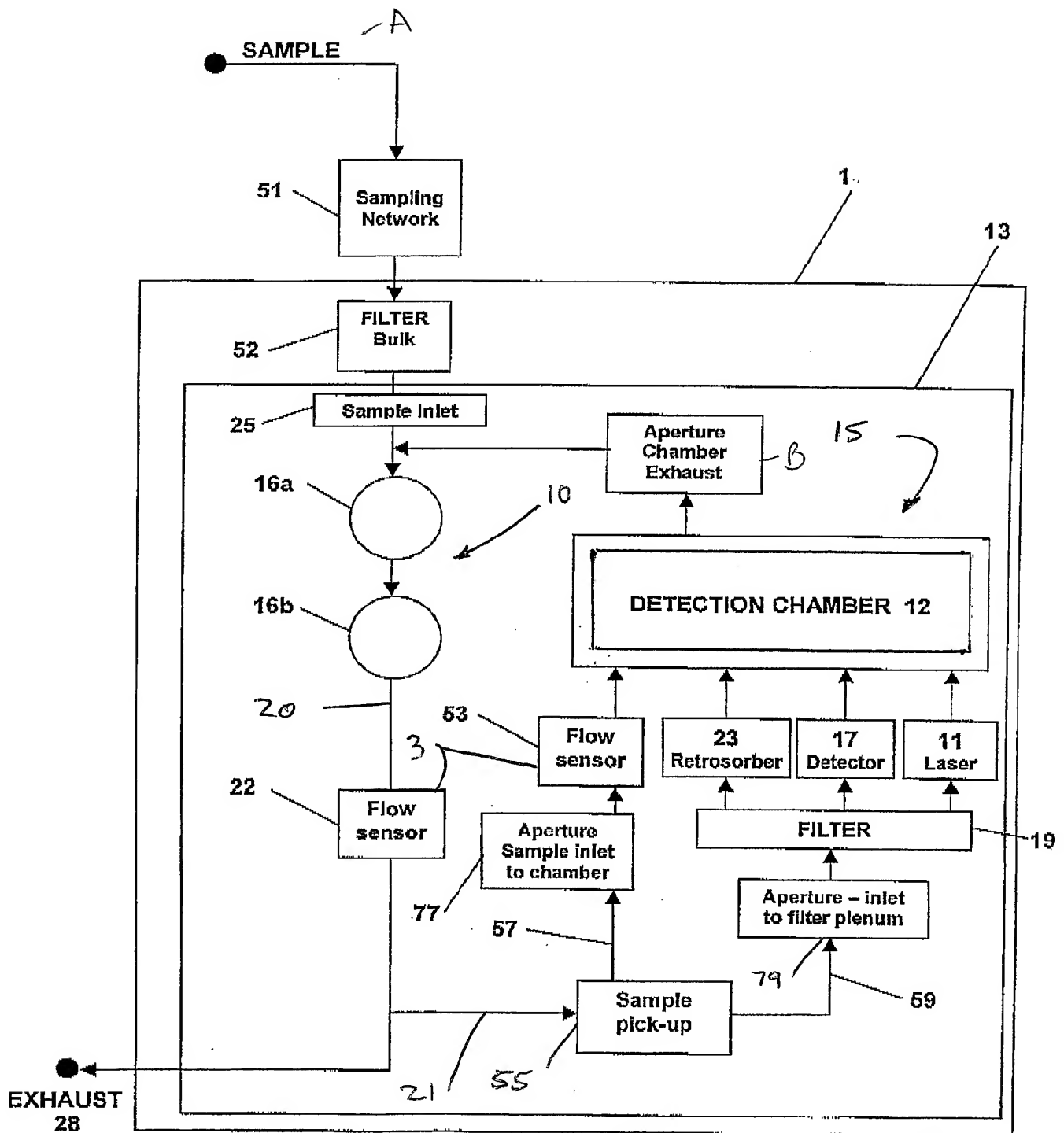


FIG. 1

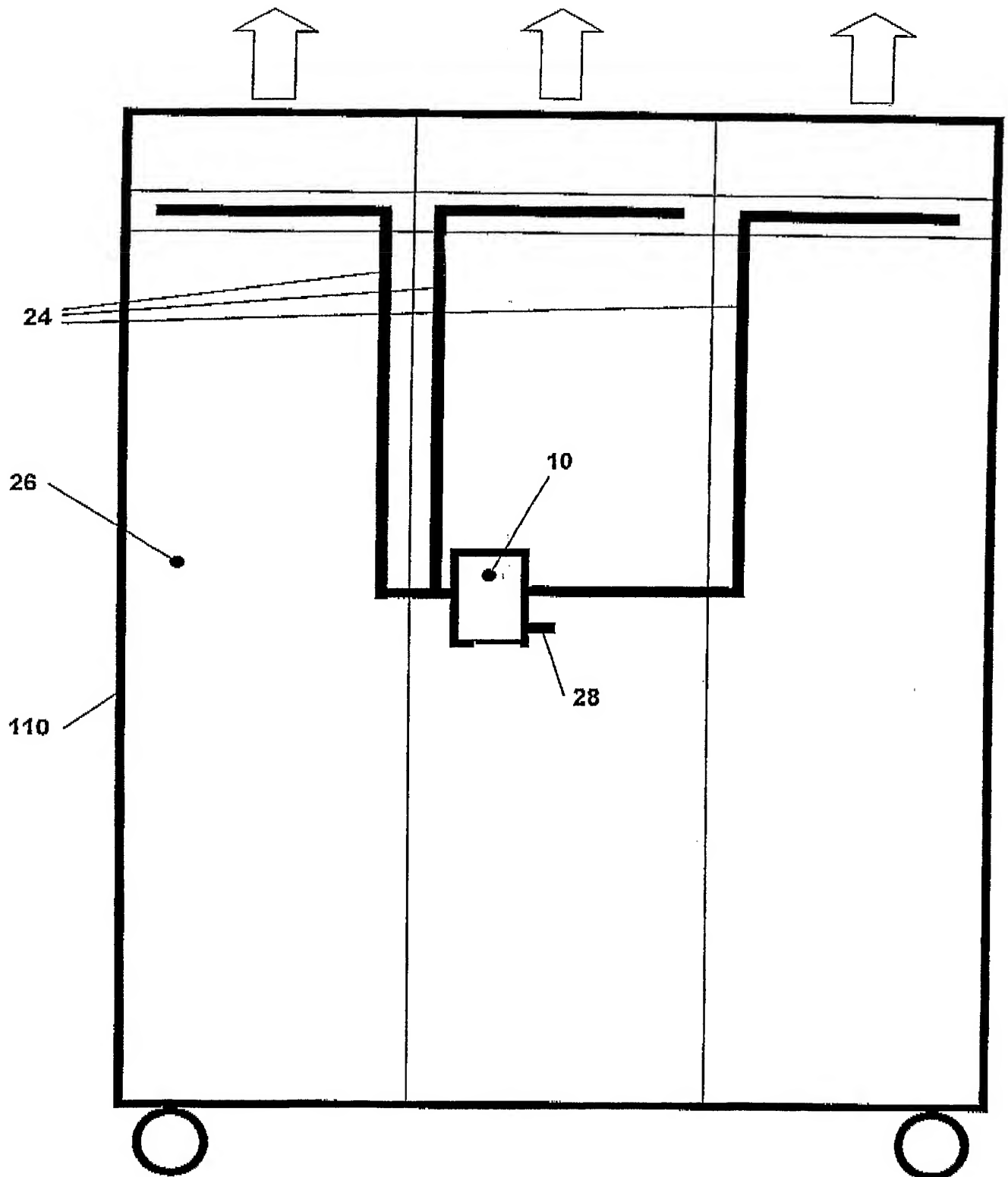


FIG. 2

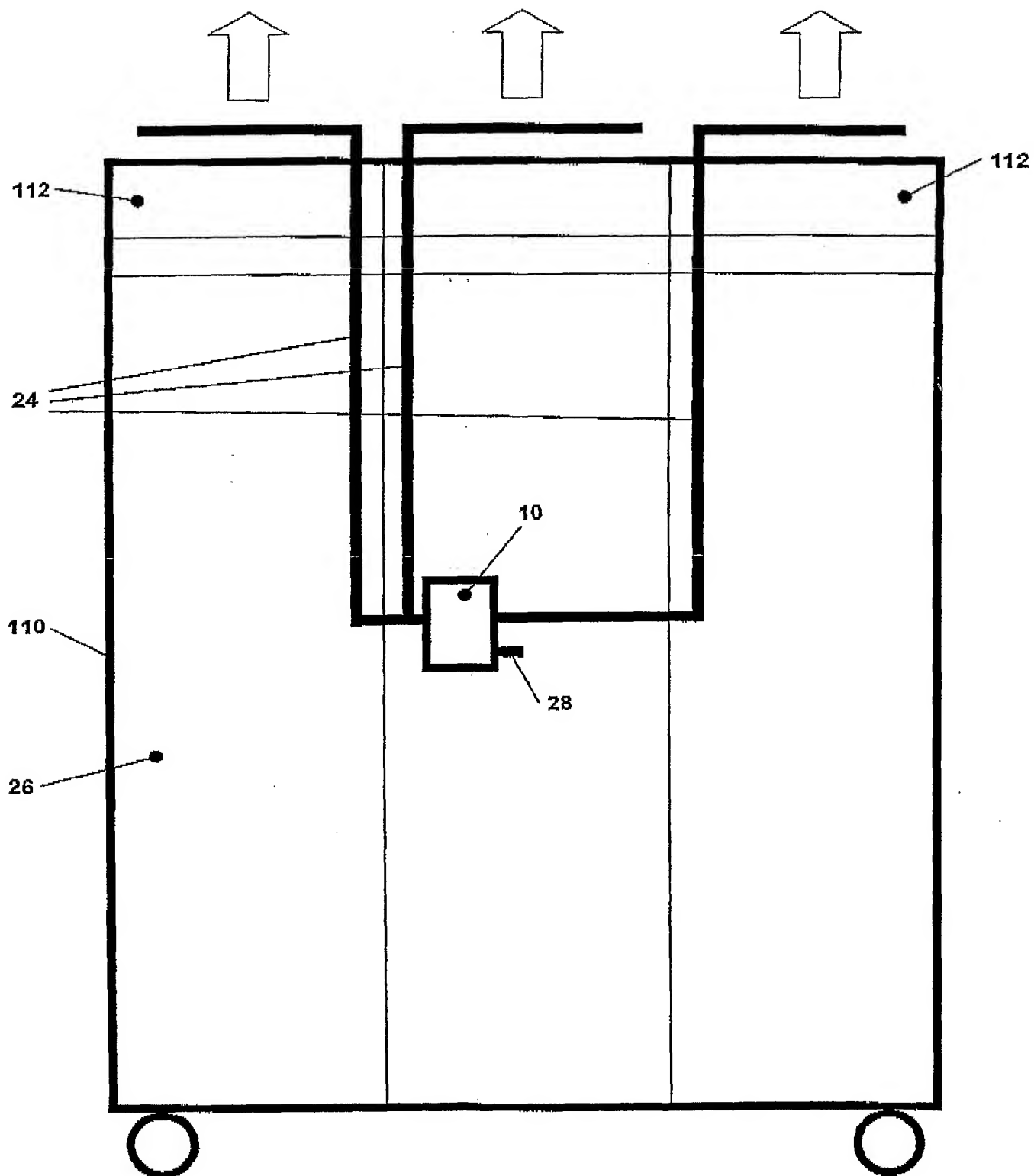


FIG. 3

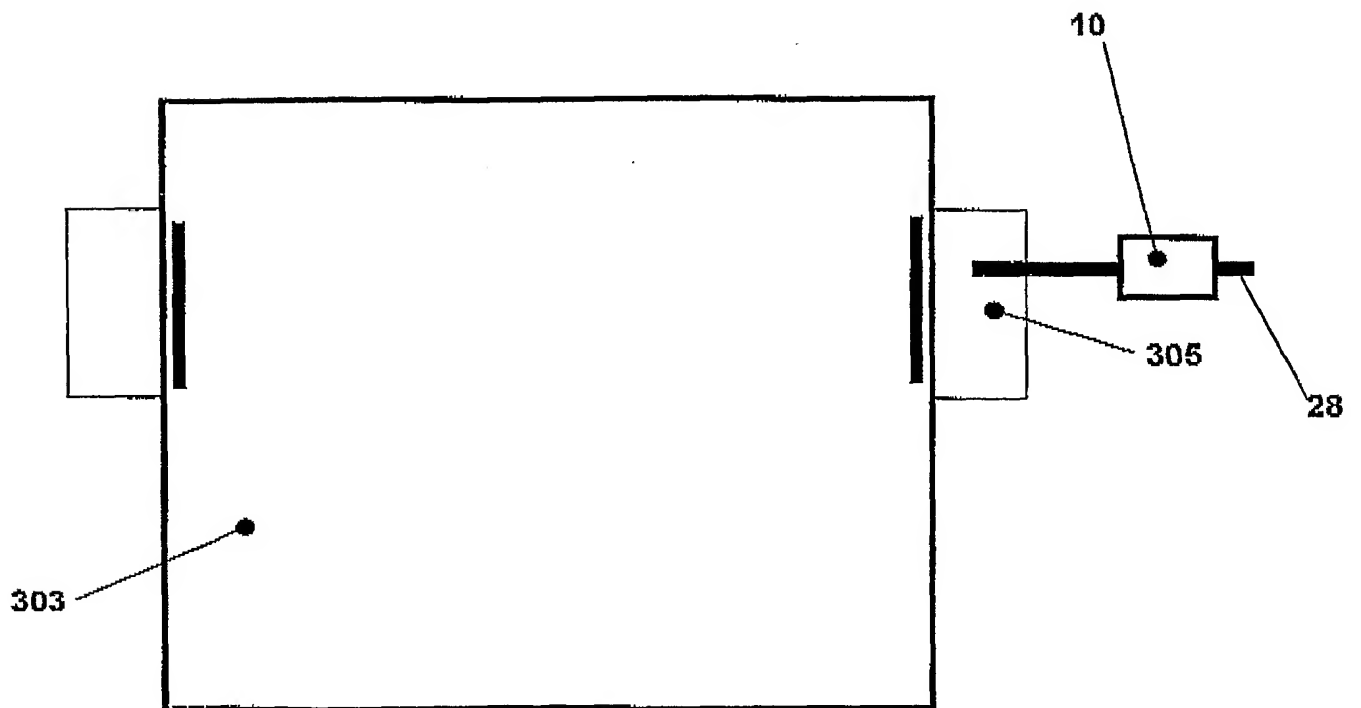
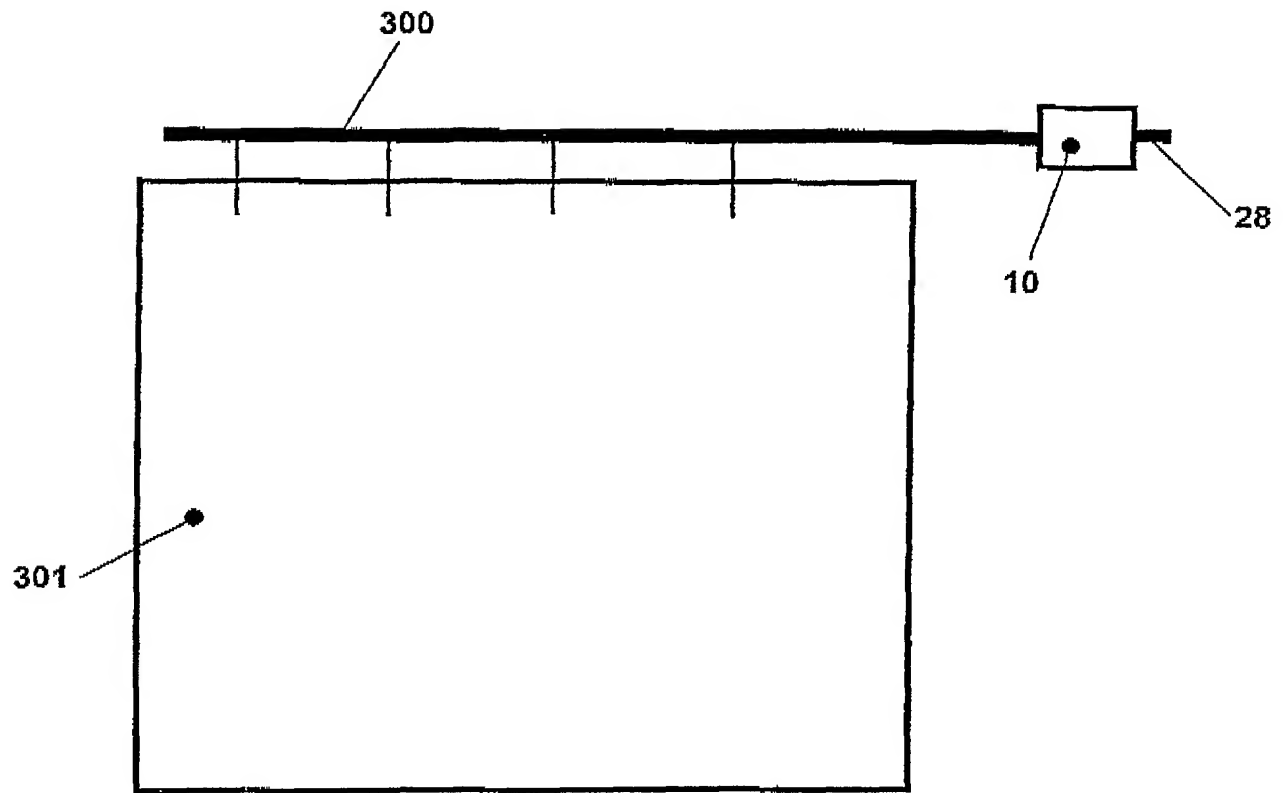


FIG. 1

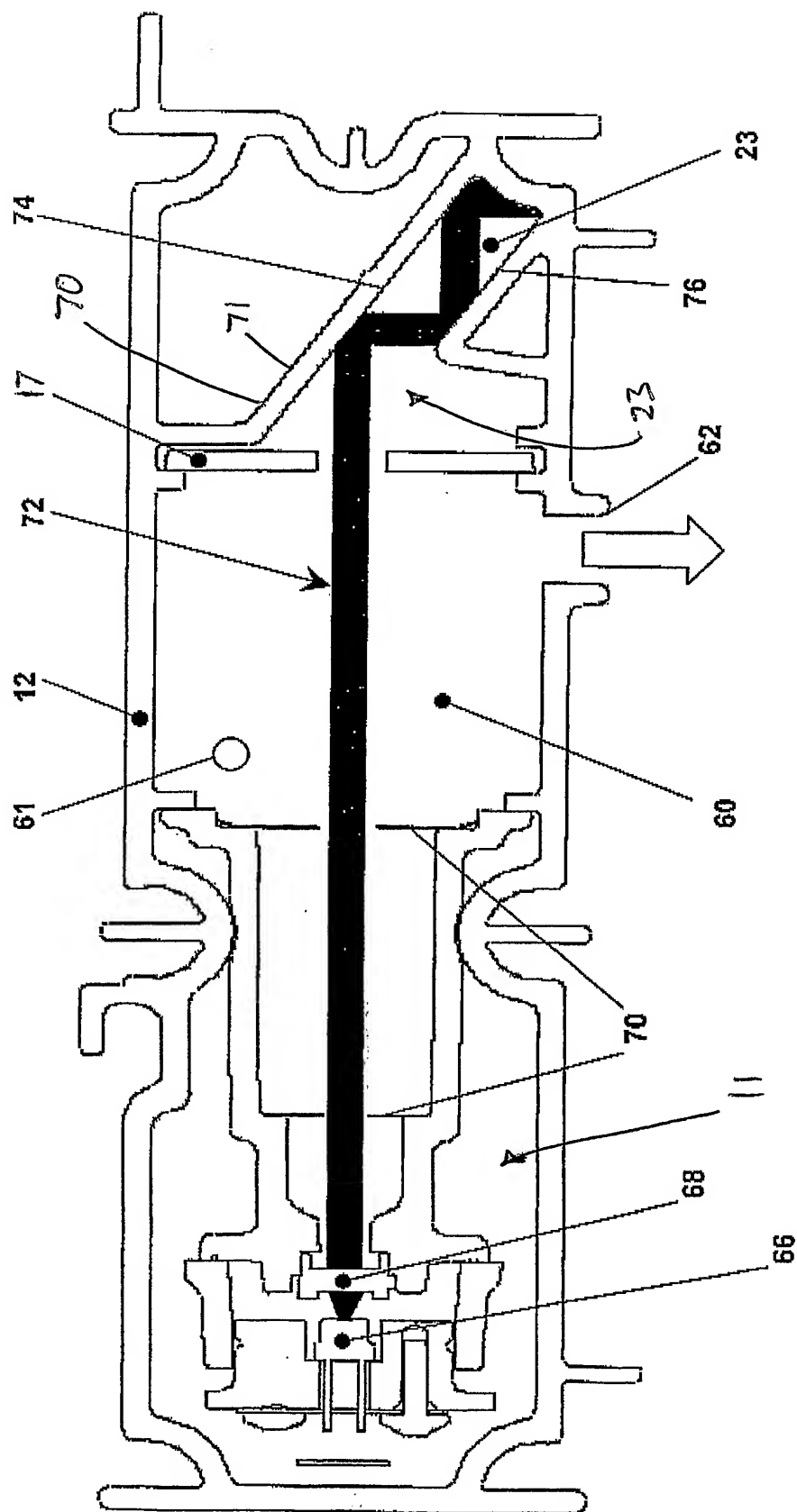


FIG. 5

INTERNATIONAL SEARCH REPORT

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PCT/AU03/00193

A. CLASSIFICATION OF SUBJECT MATTER												
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B. FIELDS SEARCHED												
Minimum documentation searched (classification system followed by classification symbols)												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPAT, USPTO, ESPACE: G08B 17/- and/or KEYWORDS: ASPIRAT+, VENTILAT+, AERAT+, PUMP+, CHAMBER?, POLARI+, TOTAL INTERNAL, BREWSTER ANGLE, SMOKE DETECT+												
C. DOCUMENTS CONSIDERED TO BE RELEVANT												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
Y	EP 1006500 A (PITTSWAY CORPORATION) 7 June 2000 Entire document	1-7										
Y	WO 97/42486 A (VISION PRODUCTS PTY. LTD) 13 November 1997 Entire document, see abstract, page 4 lines 15-20, page 5 line 25 to page 6 line 28	1-7										
Y	GB 2243475 A (WILLIAMSON et al.) 23 October 1991 Entire document	1-7										
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex												
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A" Document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L" Document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O" Document referring to an oral disclosure, use, exhibition or other means</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>"P" Document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			"A" Document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" Document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" Document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" Document published prior to the international filing date but later than the priority date claimed	
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"O" Document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family											
"P" Document published prior to the international filing date but later than the priority date claimed												
Date of the actual completion of the international search 24 March 2003		Date of mailing of the international search report 27 MAR 2003										
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929		Authorized officer CHARLES BERKO Telephone No : (02) 6283 2169										

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/00193

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 838795 A (PITTMAY CORPORATION) 29 April 1998 Entire document	1-7
P, Y	WO 2000/095705 A (MINIMAX GMBH) 28 November 2002 Entire document, see abstract and drawings	1-7
Y	GB 2347541 A (PITTMAY CORPORATION) 6 September 2000 Entire document	1-7
Y	US 6328449 a (HACSKAYLO) 11 Decmeber 2001 Entire document	8-11
Y	US 3683352 A (WEST et al.) 8 August 1972 Entire document	8-11
Y	US 55766697 A (NAGASHIMA et al.) 19 November 1996 Entire document, see abstract, column 5 line 23 60 column 6, drawings	8-11
Y	US 4064466 A (SEKI et al.) 20 December 1997 Entire document	8, 9
Y A	JP 8221675 A (NOHMI BOSAI KK) 30 August 1996 Abstract Abstract	8 1-7, 10
P, Y	RU 2184987 A (DENISOV) 11 July 2002 Abstract	8
Y	SU 1591054 A (BERMAN) 7 September 1990 Abstract	8
Y	SU 1265822 A (BERMAN) 23 October 1986 Abstract	8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/00193

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

There are **TWO** inventions claimed in the international application covered by the claims indicated as follows:

1. Claims 1-7, directed to a detector having a collocation of individual components including an aspiration system, is characterised by the system having at least two aspirators comprising a **first "special technical feature"**.
[Continued in Supplemental Box]

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/00193

Supplemental Box

(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

- 2 Claims 8-11, directed to a trap for absorbing output from a laser used to detect particulate matter passing through a detection chamber, is characterised by inclusion of an absorption plate oriented substantially at a Brewster angle to the laser light, comprising a **separate second "special technical feature"**.

It is considered that the afore mentioned groups of claims do not share either of the technical features identified. Thus a "technical relationship" between the inventions, as required by PCT rule 13.2 does not exist. Accordingly, the international application does not relate to a single inventive concept.

Information on patent family members

International application No.

PCT/AU03/00193

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
EP	1006500	AU	63144/99	CN	1256411	JP	2000172964
WO	9742486	AU	23756/97	GB	2327495	GB	2343946
		GB	2343947	US	6285291		
GB	2243475	NONE					
EP	838795	AU	42823/97	CN	1186232	JP	10197417
		US	5926098	ZA	9709455	US	6166648
WO	2002095705	DE	10124280				
GB	2347541	NONE					
US	6328449	NONE					
US	5576697	DE	4415063	GB	2277589	JP	7012724
US	3683352	NONE					
US	4064466	DE	2647934	JP	52051890	NL	7611532
JP	8221675	NONE					
							END OF ANNEX